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CUMULATIVE RISK INDEX ANALYSIS (CRIA)
(Swine Concentrated Animal Feeding Operations)

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VERSION 6.0

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CUMULATIVE RISK INDEX ANALYSIS (CRIA)

Regulated concentrated Animal Feeding Operations (CAFOs) are lots or facilities where animals have been, are, or will be stabled or confined and fed or maintained for a total of at least 45 days in any 12-month period, and the animal confinement areas do not sustain crops, vegetation, forage growth, or post-harvest residues in the normal growing season (40 CFR 122.23[b]). The following Cumulative Risk Index Analysis (CRIA) is a pilot project to consider the potential for significant, cumulative, environmental effects from swine CAFOs.

Similar risk evaluation components are found in the Human Health Risk Index (HHRI) used for Regional enforcement targeting and in the Region 6 Environmental Justice Risk Index (EJRI). The CRIA is an environmental assessment tool to facilitate communication of technical and regulatory data upon which better agency decisions can be made. The CRIA is designed to better understand the effectiveness and results of CAFO controls. The tool is not intended to be used alone in evaluating potential effects. The user must be familiar with the ranking criteria to appropriately consider the vulnerabilities of the affected environment and the potential for cumulative environmental effects.

The CRIA considers environmental vulnerabilities and potential effects of individual CAFO projects by watershed subunits called Hydrologic Unit Catalogs or HUCs. A watershed subunit is created by merging watershed area data and State stream segment information. The HUC becomes the methodology's base analytical unit.

Cumulative risks are identified through evaluation of: 1) Areas of regulated and unregulated CAFOs; 2) environmental vulnerabilities (e.g., ground water depth or soil permeability) and; and 3) impacts from known CAFO projects (water quality, vector/odor, wildlife habitat) specific to each watershed subunit.

Cumulative risk criteria are summed using a mathematical algorithm. Key components of the algorithm are Area of known CAFO projects (A_I), Area of the Watershed Subunit (A_{WS}), Degree of Vulnerability (D_V), and Degree of Impact (D_I). The CRIA algorithm is as follows:

$$CRIA = [EA / A_{WS}] D_V D_I$$

where:

CRIA = Potential for significant environmental risk

A = Area of known CAFO projects

CUMULATIVE RISK INDEX ANALYSIS (CRIA)

A_{WS} = Area of watershed subunit

D_V = Degree of Vulnerability for subunit (e.g., ground water depth, rainfall, soil permeability, populated areas).

D_I = Degree of Impact produced by regulated CAFO projects within the watershed subunit (e.g., animal population density, land application, lagoon systems).

The CRIA for swine CAFOs is calculated for each facility in a watershed subunit area. Total areas (A) of known projects in a watershed subunit are scored from 1 to 4 based on the percentage of the watershed area they represent. Vulnerability and impact factors are identified, and criteria for each were developed.

Each D_V and D_I criteria is scored from 1 to 5.

The calculations involve:

- 1) summing the areas for known projects (A) and determining what percent of a watershed subunit is affected. ($[EA / A_{WS}] \times 100$); these percentages are scored on a 1 to 4 scale [no project(s) = 0 score].
- 2) summing the vulnerability and impact criteria scores, and calculating the average for D_V and D_I respectively;
- 3) multiplying the A score by the average D_V score by the average D_I score.

The maximum score possible in a watershed subunit (HUC) is 100. The summation factor (EA) is cumulative for CAFOs in the watershed subunit. Maximum rank for $[EA_I / A_{WS}]$ is 4, maximum for D_V is 5, maximum score for D_I is 5.

$$\begin{aligned} \text{CRIA} &= [EA_I / A_{WS}] (D_V) (D_I) \\ &= [4] (5) (5) = 100 \end{aligned}$$

I. WATERSHED SUBUNIT AREA [EA / A_{ws}] CRITERIA:

[EA_I / A_{ws}] is the ratio of the cumulative area effected to the watershed subunit area evaluated. [EA_I / A_{ws}] :

CRIA Area Criteria:

Area	Score
0%	= 0
< 5%	= 1
≥ 5% and < 10%	= 2
≥ 10% and < 15%	= 3
≥ 15%	= 4

References:

U.S. Geological Survey. 1995. Watershed Boundaries for Oklahoma, Joel Cederstrand and Allen Rey, Oklahoma City, OK.

Oklahoma Department of Agriculture. 1996. CAFO Database. Oklahoma City, OK.

U.S. EPA. 1990. Region 6 Comparative Risk Project, Overview Report. Office of Planning and Analysis. Dallas, TX.

U.S. EPA. 1992. A Synoptic Approach to Cumulative Impact Assessment: A Proposed Methodology. Office of Research and Development, EPA/600/R-92/167, Washington, D.C.

U.S. EPA. CAFO Location Data Set. Region 6 GIS Data Library. Dallas, TX.

U.S. EPA. Undated. New Source NPDES General Permit Environmental Information Documents. Office of Planning and Coordination. Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) One square mile = 27,878,400 sq.ft.
- 2) The potential for negative environmental impact increases as the percentage of watershed subunits (HUC) used by CAFO industries increases.
- 3) Cumulative impacts can be measured by assessing known CAFOs impacts in watershed subunits.

EPA Contacts (name, mail-code, telephone number):

Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)

II. DEGREE OF VULNERABILITY (D_v) CRITERIA:

D_v is the sum of individual criteria scores divided by the number of vulnerability factors used in the Degree of Impact (D_v) assessment. [v scores / no. v]

1) D_v Criteria: Ground Water Probability

Probability ¹	Score
$\leq 2.5\%$	= 1
$> 2.5\%$ and $\leq 5\%$	= 2
$> 5\%$ and $\leq 10\%$	= 3
$> 10\%$ and $\leq 20\%$	= 4
$> 20\%$	= 5

¹Probability of ground water being within 8 ft. of surface.

References:

NRCS (National Resource Conservation Service), downloaded from NRCS in Oklahoma City, OK. Ten acre grid soils data. 1995/96?

U.S. EPA Region 6, Mike Bechdol, Cross Functional Workgroup.

U.S. EPA. 1987. Drastic: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings. EPA/600/2-87/035. Environmental Research Laboratory. Ada, OK.

U.S. EPA Region 6, GIS, ERI Directory, Subdirector NewSoils.arp, (Jeff Danielson, CDSI)

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Area of the CAFO is represented as the CAFO area plus a ten acre buffer around each site.
- 2) Only those 10 area square areas with a $> 20\%$ probability of ground water being within eight feet of the surface (scaling score of 5) were used for the criteria site percentage estimate.
- 3) The eight foot soil profile estimates the probability of ground water vulnerability beneath CAFO facility and buffer area.
- 4) The higher the probability of ground water beneath the CAFO facility the more vulnerable the resource.
- 5) This criteria may extend outside the watershed.

EPA Contacts (name, mail-code, telephone number):

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Tom Nelson (6WQ-O), EPA Region 6, Dallas, TX (X7128)

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2) D_v Criteria: Rainfall

Rainfall	Score
< 12.5 in./yr	= 1
≥ 12.5 in./yr and < 25 in./yr	= 2
≥ 25 in./yr and < 37.5 in./yr	= 3
≥ 37.5 in./yr and < 50 in./yr	= 4
≥ 50 in./yr	= 5

References:

Blacklands Research Center, 1995. Humus - Hydrologic Unit Modeling for the United States, USDA/NRCS, USDA/ARS, and Texas A&M University, College Station, TX.

U.S. EPA Region 6, GIS, (Tom Nelson, 6WQ-0)

U.S. EPA, 1991. Regional Assessment of Aquifer Vulnerability and Sensitivity in the Conterminous United States. EPA/600/2-91/043, Office of Research and Development, Washington, D.C.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The greater the annual rainfall, the more infiltration to the ground water.
- 2) The greater the annual rainfall, the more runoff to surface water.
- 3) All known CAFOs in a watershed subunit (HUC) receive a comparable amount of annual rainfall.

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3) D_v Criteria: Surface Water Use

Supporting Designated Use	Score
no data	= 1
≥ 99%	= 2
< 99% and ≥ 76%	= 3
< 76% and ≥ 50%	= 4
< 50	= 5

References:

U.S. EPA, 1994. Watershed Agricultural Impact Task Force, W.A.I.T. Report, Research Triangle Institute (RTI), Charles Spooner.

U.S. EPA. 1994. Clean Water Act, Section 305 (b): Oklahoma State Water Quality Inventory Reports, 303 (d) List..Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) CWA 305(b) reports describe the surface water quality for 8 digit HUCs.
- 2) Stream segments with no data are assumed to be good quality.
- 3) Designated uses are defined in the referenced EPA W.A.I.T. report.

EPA Contacts (name, mail-code, telephone number):

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Charles Spooner, (RTI), EPA HQ, Washington, D.C. (202/260-1314)
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4) D_v Criteria: Distance to Surface Water

Distance to Vulnerable Water	Score
> 8,100 ft	= 1
≤ 2,700 ft and > 8,100 ft	= 2
≤ 900 ft and > 2,700 ft	= 3
≤ 300 ft and > 900 ft	= 4
≤ 300 ft	= 5

References:

U.S. Census Bureau, 1992. TIGER/Line Census Files, (machine-readable data files) prepared by the Bureau of the Census, Washington, D.C.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Vulnerable surface waters for this criteria are only those in the U.S. Census Bureau, TIGER 1992 Database.
- 2) The closest surface water is assumed to be down gradient from CAFO pollution sources.
- 3) Distance to surface water is measured as straight line distance from the outer boundary of the land application area (incorporation of drainage distances are future enhancements).
- 4) This criteria may extend outside the watershed.

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5) D_v Criteria: Population Around Facility

Population (per square mile) ¹	Score
< 20	= 1
≥ 20 and < 40	= 2
≥ 40 and < 60	= 3
≥ 60 and < 80	= 4
≥ 80	= 5

¹Within two (2) mile buffer around CAFO.

References:

U.S. Census Bureau, 1990. Census of Population and Housing, 1990: Public Law. (P.L.) 94-171 Data on CD-ROM (Name of State) [machine-readable data files] / prepared by the Bureau of the Census. -- Washington: The Bureau [producer and distributor], 1991.

U.S. EPA, 1991. Regional Assessment of Aquifer Vulnerability and Sensitivity in the Conterminous United States. EPA/600/2-91/043, Office of Research and Development, Washington, D.C.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Human population areas can be negatively impacted by known CAFO industries.
- 2) The closer populated areas are to known CAFOs, the more potential for negative impacts.
- 3) Environmental Justice Index (EJI) or other ethnic/demographic considerations will be conducted as a separate assessment.
- 4) This criteria may extend outside the watershed.

EPA Contacts (name, mail-code, telephone number):

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 David Parrish (6EN-X), EPA Region 6, Dallas, TX (X8352)
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- 6) D_v Criteria: Other Industries, Pollution Sources, or Protected Lands (Quadmapper Data¹ and state data)

<u>Number within a two mile buffer</u>	<u>Score</u>
No industries or land areas	= 1
One industry or land area	= 2
Two industries or land areas	= 3
Three industries or land areas	= 4
Four industries or land areas	= 5

¹Locations for solid waste landfills, water supply intake points, RCRA Sites, Indian Reservations, Superfund (NPL) sites, Federal Facilities, and Toxic Release Inventory (TRI) sites.

References:

U.S. EPA, 1996. Region 6 EPA Geographic Information System (GIS) Data Library. Quadmapper Documentation , Office of Planning and Coordination, Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Watersheds can be negatively effected by the cumulative impacts of regulated CAFOs in combination with other industries.
- 2) Other industries are defined as those in the Region 6 EPA Quadmapper database and CAFO locations from state databases.
- 3) Industries within two miles of regulated CAFO facilities are factors in the assessment of cumulative environmental impacts.
- 4) This criteria may extend outside the watershed.

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7) D_v Criteria: Wildlife Habitats

Coverage of HUC Subunit	Score
< 20%	= 1
≥ 20% and < 30%	= 2
≥ 30% and < 40%	= 3
≥ 40% and < 50%	= 4
> 50%	= 5

References:

NRCS, 1995. Landuse Dataset, Oklahoma City, OK

Department of the Interior, 1976. A Land Use and Land Cover Classification System for Use with Remote Sensor Data, James Anderson, third printing 1978.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Wildlife Habitats are represented by wetlands, rangelands, forest lands, woodlands, including bottomlands.
- 2) Percent coverage is quantitative only. No decisions as to wildlife habitat quality were made.
- 3) There is no association between this vulnerability score for wildlife habitats and the potential effect, if any, on listed Federal Endangered and Threatened Species, subject to the requirements of the ESA.
- 5) The EPA will conduct a separate review with the U.S. Corps of Engineers and/or the U.S. Natural Resources Conservation Service, as necessary, to document compliance with Section 404 of the Clean Water Act.

EPA Contacts (name, mail-code, telephone number):

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8) D_v Criteria: Soil Permeability

Rating ¹	Score
< 0.02 in./hr	= 1
≥ 0.02 in./hr and < 0.6 in./hr	= 2
≥ 0.6 in./hr and < 2.0 in./hr	= 3
≥ 2.0 in./hr and < 6.0 in./hr	= 4
≥ 6.0 in./hr	= 5

¹Permeability ratings are by 10 acre grids. The average of the grids, inside or touching the CAFO boundary is ranked 1-5. In addition a site is scored a 5 if >20% of the CAFO area and adjacent buffer is ≥ 6.0 in./hr.

References:

NRCS (National Resource Conservation Service), downloaded from NRCS in Oklahoma City, OK. Ten acre grid soils data. 1995/96?

U.S. EPA, 1993. A Review of Methods for Assessing Aquifer Sensitivity and Ground Water Vulnerability to Pesticide Contamination. 813-R-93-002, Office of Water (WH-550), Washington, D.C.

Lin, H.S., H.D. Scott, and Jim McKinny, 1995. Identification of Optimal Locations for Sampling Ground Water of Pesticides in the Mississippi Delta Region of Eastern Arkansas, Department of Agronomy, University of Arkansas, Fayetteville, AR.

U.S. EPA, 1991. Regional Assessment of Aquifer Vulnerability and Sensitivity in the Conterminous United States. EPA/600/2-91/043, Office of Research and Development, Washington, D.C.

U.S. EPA, 1996. Ground Water Protection Methodology. Region 6 EPA, Ground Water Protection Branch, Dallas, TX

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Soil and ground water characteristics are assumed to be consistent over the CAFO area. Slope of the land is not evaluated.
- 2) Permeability ratings refer to the upper six to eight feet.
- 3) Although CAFO land application activities normally include some soil disturbance (e.g., tilling, irrigation, disking, etc.), permeability ratings are based upon undisturbed soil conditions.
- 4) This criteria may extend outside the watershed.

EPA Contacts (name, mail-code, telephone number):

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9) D_v Criteria: Ground Water Quality

Average Nitrate-Nitrite	Score
< 3 mg/L	= 1
≥ 3 mg/L and < 4.5 mg/L	= 2
≥ 4.5 mg/L and < 6 mg/L	= 3
≥ 6 mg/L and < 7.5 mg/L	= 4
≥ 7.5 mg/L	= 5

References:

Oklahoma Water Resources Board, 1993. Statistical Summary of Groundwater Quality Data: 1986-1991 for the Major Groundwater Basins in Oklahoma, FY 93 106 Groundwater Task 400, Planning and Management, Bob Fabian, Oklahoma City, OK.

U.S. EPA. 1991. Protecting the Nation's Ground Water: EPA's Strategy for the 1990's (part D: Agency Policy on EPA's Use of Quality Standards in Ground Water Prevention and Remediation Activities). 21Z-1020. Office of the Administrator (WH-550G). Washington, D.C.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The Maximum Contaminant Level (MCL) for nitrate in ground water is 10 mg/L established under the Safe Drinking Water Act.
- 2) Phosphates and other nutrients are not included in this criteria. Nutrients will be covered in separate criteria (i.e. Surface Water Quality)
- 3) Oklahoma ground water quality data is presented at the county and aquifer level. Approximation of sampling locations were derived from combining aquifer, watershed, river, and county location data.
- 4) Where counties include more than one aquifer, the watershed that incorporated a certain river was assumed to be associated with the aquifer with the same name as the river.

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 Bob Fabian, Oklahoma Water Resources Board, Planning and Management Division, Oklahoma City, OK (405/530-8800)
 Clay Chesney (6WQ-SG), EPA Region 6, Dallas, TX (X7128)
 Jeff Danielson (CDSI Contractor) EPA Region 6, Dallas, TX (X8559)
 David Parrish, (6EN-X), EPA Region 6, Dallas, TX (X8352)

10) D_v Criteria: Economic (Environmental Justice)

Economic Ranking by EJ Method ¹	Score
Economic status is ≤ the State average	= 1
Status is ≤ 1.33 times the State avg.	= 2
Status is ≤ 1.66 times the State avg.	= 3
Status is ≤ 2 times the State avg.	= 4
Status is > 2 times the State avg.	= 5

¹EJ rankings are modified to only the Economic factor.

References:

U.S. Census Bureau, 1990. Census of Population and Housing, 1990: Public Law. (P.L.) 94-171 Data on CD-ROM (Name of State) [machine-readable data files] / prepared by the Bureau of the Census. -- Washington: The Bureau [producer and distributor], 1991.

U.S. EPA. 1995. Computer Assisted Environmental Justice Index Methodology (August 1995 Revision). Office of Planning and Analysis, Enforcement Division, Region 6 Environmental Protection Agency, Dallas, TX.

U.S. EPA. 1994. Executive Order 12898: "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations". 59 Federal Register Notice 7629 (1994).

Council of Environmental Quality. 1996. Draft Guidance of Addressing Environmental Justice under the National Environmental Policy Act (NEPA) (April, 1996). Executive Office of the President, Washington D.C.

U.S. EPA. 1992. Environmental Equity: Reducing Risk for All Communities. Office of Policy, Planning, and Evaluation (PM-221), EPA230-R-92-008, June 1992. Environmental Protection Agency, Washington, D.C.

Lavelle, M., and M. Coyle. 1992. Unequal Protection: The Racial Divide in Environmental Law. The National Law Journal, Vol. 15, No. 3,2-12.

U.S. Census Bureau 1990, TIGER 1992 update, STF3A Census Coverage, P.L. 94-171.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Demographic data will be 1990 STF3A Census coverage.
- 2) The economic analysis calculated for a four mile radius (50 square miles) from the center point of CAFO facilities.
- 3) This criteria may extend outside the watershed.

EPA Contacts:

Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Jeff Danielson (CDSI Contractor) EPA Region 6, Dallas, TX (X8559)

11) D_v Criteria: Minority (Environmental Justice)

Minority Ranking by EJ Method ¹	Score
Minority status is ≤ the State average	= 1
Status is ≤ 1.33 times the State avg.	= 2
Status is ≤ 1.66 times the State avg.	= 3
Status is ≤ 2 times the State avg.	= 4
Status is > 2 times the State avg.	= 5

¹EJ rankings are modified to only the minority factor.

References:

U.S. Census Bureau 1990, Census of Population and Housing, Summary Tape File 3 on CD ROM (Name of State) [machine-readable data files] / prepared by the Bureau of the Census. --Washington: The Bureau [producer and distributor], 1992.

U.S. EPA. 1995. Computer Assisted Environmental Justice Index Methodology (August 1995 Revision). Office of Planning and Analysis, Enforcement Division, Region 6 Environmental Protection Agency, Dallas, TX.

U.S. EPA. 1994. Executive Order 12898: "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations". 59 Federal Register Notice 7629 (1994).

Council of Environmental Quality. 1996. Draft Guidance of Addressing Environmental Justice under the National Environmental Policy Act (NEPA) (April, 1996). Executive Office of the President, Washington D.C.

U.S. EPA. 1992. Environmental Equity: Reducing Risk for All Communities. Office of Policy, Planning, and Evaluation (PM-221), EPA230-R-92-008, June 1992. Environmental Protection Agency, Washington, D.C.

Lavelle, M., and M. Coyle. 1992. Unequal Protection: The Racial Divide in Environmental Law. The National Law Journal, Vol. 15, No. 3, 2-12.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Demographic data will be 1990 STF3A Census coverage.
- 2) The minority analysis calculated for a four mile radius (50 square miles) from the center point of CAFO facilities.

3) This criteria may extend outside the watershed.

EPA Contacts:

Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)

12) D_v Criteria: Surface Water Quantity

Stream & Shoreline	Score
< 0.917 mi/mi ²	= 1
≥ 0.917 mi/mi ² and < 1.15 mi/mi ²	= 2
≥ 1.15 mi/mi ² and < 1.43 mi/mi ²	= 3
≥ 1.43 mi/mi ² and < 1.7 mi/mi ²	= 4
> 1.7 mi/mi ²	= 5

References:

1) Vulnerable surface waters for this criteria are only those in the U.S. Census Bureau, TIGER 1992 Database.

Wetzel, R., 1983. Limnology, 2nd ed., Saunders College Publishing, New York, NY.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Surface waters are calculated for segment and shoreline distances for streams, rivers, and lakes. Scaling scores (rankings) are derived from total miles in a watershed divided by the area in square miles of associated HUCs.
- 2) River and lake surface water areas and depths are not considered.
- 3) The more surface water area present in a watershed, the higher potential for ecological impacts.
- 4) Shoreline is of considerable interest because of the sensitivity of associated ecological communities.

EPA Contacts (name, mail-code, telephone number):

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 Tom Nelson (6WQ-O), EPA Region 6, Dallas, TX (X7128)
 David Parrish, (6EN-X), EPA Region 6, Dallas, TX (X8352)

13) D_v Criteria: Water Quality (STORET Data)

# STORET Exceedances / Watershed ft ²	Score
< 5.00 X 10 ⁻¹²	= 1
≥ 5.00 X 10 ⁻¹² and < 5.00 X 10 ⁻¹¹	= 2
≥ 5.00 X 10 ⁻¹¹ and < 5.00 X 10 ⁻¹⁰	= 3
≥ 5.00 X 10 ⁻¹⁰ and < 5.00 X 10 ⁻⁹	= 4
≥ 5.00 X 10 ⁻⁹	= 5

References:

U.S. EPA, Storet Database, Paul Koska and Mike Bechdol

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Assessed Safe Drinking Water Act (SDWA) contaminants (22 volatile organic compounds, 35 organics/pesticides, 17 inorganics/metals, and trihalomethane) can adversely impact surface waters.
- 2) Water criteria standards from the SDWA are compared to STORET ambient water data. Comparisons for 65 SDWA contaminants were matched to surface (i.e. stream, lake, reservoir) and ground water (well and springs) STORET data.
- 3) Exceedances are defined as STORET sampling station data reporting chemical concentration greater than the SDWA MCLs (Maximum Concentration Levels). Sixteen years of data were evaluated.
- 4) Eight digit HUCs were evaluated. The ranking values were the quotients of the number of exceedances in specific HUCs divided by the area in square feet of the associated HUC.

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Jeff Danielson (CDSI Contractor) EPA Region 6, Dallas, TX (X8559)

14) D_v Criteria: Other¹ CAFO Facilities

Unregulated CAFOs in HUC	Score
< 20%	= 1
≥ 20% and < 30%	= 2
≥ 30% and < 40%	= 3
≥ 40% and < 50%	= 4
> 50%	= 5

¹Operating under EPA NPDES General Permit and/or State permit, and unregulated CAFOs.

References:

- 1) Oklahoma Department of Agriculture. 1996. CAFO Database. Oklahoma City, OK.
- 2) U.S. EPA. 1996. CAFO Location Data Set. Region 6 GIS Data Library. Dallas, TX.
- 3) Census Bureau. 1992 Census of Agriculture. Zip code tabulations.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The greater the percentage of unregulated CAFOs in an HUC, the greater the potential for negative environmental impacts.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Tom Nelson (6WQ-O), EPA Region 6, Dallas, TX (X7128)
 David Parrish, (6EN-X), EPA Region 6, Dallas, TX (X8352)

III. DEGREE of IMPACT (D_I) CRITERIA

D_I is the sum of individual impact criteria scores divided by the number of impact factors used in the Degree of Impact (D_I) assessment. [I scores / no. I]

CRIA Impact Criteria:

- 1) D_I Criteria: Livestock Population Density LPD - Animal Units/CAFO Acres (total acreage)

<u>Livestock Pop. Density (LPD)¹</u>	<u>Score</u>
LPD \leq 10	= 1
LPD $>$ 10 and \leq 20	= 2
LPD $>$ 20 and \leq 25	= 3
LPD $>$ 25 and \leq 30	= 4
LPD $>$ 30	= 5

¹Animal Units/CAFO Acres (LPD of 10 is 25 swine per acre)

References:

Agri-Waste Technology, Inc., HUC Cumulative Risk Index Analysis Swine Producer Group, October 26, 1996, Raleigh, NC.

U.S. EPA. 1995. Guide Manual on NPDES Regulations for Concentrated Animal Feeding Operations. Final. EPA 833-B-95-001. Office of Water (4203). Washington, D.C.

National Archives and Records Administration. 1994. Code of Federal Regulations, Protection of Environment. 40 Parts 100 to 149. Revised July 1.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) 0.4 animal unit is assigned to each hog weighing more than 55 lbs. Two thousand, five hundred swine over 55 lbs. each equals 1000 animal units. For piglets, 0.2 is considered an equivalent animal unit.
- 2) The fewer the number of animal units per facility acre the less potential for impacts.
- 3) CAFO acres is the total acreage and includes buildings, treatment facilities, and application areas.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Chris Ruhl (6EN-AS), EPA Region 6, Dallas, TX (X7356)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

2) D_I Criteria: Lagoon Loading Rate

NRCS Lagoon Loading Rate	Score
≤ 100% NRCS Lagoon Loading Rate	= 1
> 100% and ≤ 110%	= 2
> 110% and ≤ 120%	= 3
> 120% and ≤ 130%	= 4
> 130%	= 5

References:

Agri-Waste Technology, Inc., HUC Cumulative Risk Index Analysis Swine Producer Group, October 26, 1996, Raleigh, NC.

U.S. Department of Agriculture, Natural Resource Conservation Service. Agricultural Waste Management System Component Design, Figure 10-22 Anaerobic Lagoon Loading Rate.

Watson, Harold. 1991. Lagoons for Animal Waste Disposal. Alabama Cooperative Extension Service. Auburn University, AL.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) NRCS has developed a map that suggests the appropriate lagoon design volume (pounds of volatile solids per 1000 cubic feet of lagoon per day). This design is exclusive of sludge storage and waste storage.
- 2) Permitted facilities are not expected to exceed the 100% Lagoon Loading Rate whereas non-permitted facilities may exceed 100%.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

3) D_I Criteria: Treatment System Liner

Hydraulic Conductivity Rate ¹	Score
≤ 100% Hydraulic Conductivity Rate	= 1
> 100% and ≤ 105%	= 2
> 105% and ≤ 110%	= 3
> 110% and ≤ 115%	= 4
> 115%	= 5

¹EPA NPDES General Permit for CAFOs (1993) defines the maximum acceptable hydraulic conductivity as 1×10^{-7} cm/sec.

References:

U.S. EPA, 40 CFR 122, Liner Construction, NPDES General Permit for Discharges from Concentrated Animal Feeding Operations.

Agri-Waste Technology, Inc., HUC Cumulative Risk Index Analysis Swine Producer Group, October 26, 1996, Raleigh, NC.

U.S. Department of Agriculture, Soil Conservation Service. Agricultural Waste Management System Component Design, Figure 10-22 Anaerobic Lagoon Loading Rate.

Watson, Harold. 1991. Lagoons for Animal Waste Disposal. Alabama Cooperative Extension Service. Auburn University, AL.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The design, construction and operation of lagoons determine their effectiveness.
- 2) Permitted facilities are not expected to exceed the 100% Hydraulic Conductivity Rate whereas non-permitted facilities may exceed 100%.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

4) D_I Criteria: Land Application Technology

Land Application Systems	Score
Innovative Technology	= 1
Desirable	= 2
Conventional	= 3
Undesirable	= 4
None	= 5

References:

Dendy, D. and M. Ladd 1996. Comments on Draft Cumulative Risk Analysis, ACCORD Agriculture, Inc., Farnsworth, TX.

U.S. EPA, Region 6, 1996. Swine CAFO Odors: Guidance for Environmental Impact Assessment, Lee Wilson and Associates, Santa Fe, NM.

Miner, J.R. 1995. An Executive Summary: A Review of the Literature on the Nature and Control of Odors from Pork Production Facilities, Prepared for the National Pork Producers Council, Des Moines, Iowa, by Ron Miner, Bioresource Engineering Department, Oregon State University, Corvallis, OR.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Innovative technology includes subsurface injection and tillage of waste within three hours of application.
- 2) Desirable technology includes low pressure sprinkler systems (15-20 psi), minimizing land application impacts near residents, low trajectory spray, and avoiding extra-fine spray.
- 3) Conventional technology includes medium pressure (30-70 psi) sprinkler systems, avoids weekends and holiday application, and uses vegetative screens.
- 4) Undesirable technology includes high pressure sprinkler systems (>80 psi), high trajectory spray, does not avoid application on weekends or holidays, and does not use vegetative screens.
- 5) Subsurface injection and tillage technology is assumed to avoid high water tables and highly permeable soils.
- 6) Injection of slurry can reduce the odor by 80% and can reduce ammonia emissions by 95%.
- 7) Above ground application of wastes should be tilled into the soil as soon as possible to reduce the rate of odor emissions. Plowing immediately after application reduces the rate of odor emission during the first hour by 85%.

EPA Contacts:

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

5) D_I Criteria: Nitrogen Budget

Crop Nitrogen Budget ¹	Score
≤ 100%	= 1
> 100% and ≤ 110%	= 2
> 110% and ≤ 120%	= 3
> 120% and ≤ 130%	= 4
> 130%	= 5

¹The Crop Nitrogen Budget percent is the ratio of the sum of the annual plant available nitrogen produced and the commercial nitrogen fertilizer to be used divided by the crop nitrogen that can be utilized each year times 100.

References:

Agri-Waste Technology, Inc., HUC Cumulative Risk Index Analysis Swine Producer Group, October 26, 1996, Raleigh, NC.

U.S. EPA, 40 CFR 122, Wastewater Removal and Land Application, NPDES General Permit for Discharges from Concentrated Animal Feeding Operations.

U.S. Natural Resource Conservation Service (NRCS). Estimate of land Area Needed for Waste Application and Value of Nutrients Applied.

U.S. NRCS. Agricultural Waste Management Field Handbook, Part 651, Issued April 1992.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Annual plant available nitrogen is the amount of nitrogen available to the plant from the applied waste effluent.
- 2) Land application crops typically require commercial fertilizers in addition to nutrients from waste effluent.
- 3) Application rates of waste effluent might be limited by other parameters (salt loadings, phosphorus loadings, hydraulic loadings).

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

6) D_I Criteria: Storage Capacity

Storage Volume	Score
> 90 days	= 1
≤ 90 days and ≥ 60	= 2
< 60 days and ≥ 30	= 3
< 30 days and ≥ 15	= 4
> 15 days	= 5

References:

Agri-Waste Technology, Inc., HUC Cumulative Risk Index Analysis Swine Producer Group, October 26, 1996, Raleigh, NC.

U.S. EPA, 40 CFR 122, Wastewater Removal and Land Application, NPDES General Permit for Discharges from Concentrated Animal Feeding Operations.

U.S. Natural Resources Conservation Service. 1992. Agricultural Waste Management Field Handbook, Part 651, Issued April.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Storage volume above the 25 year-24 hour storm can minimize potential environmental impacts.

EPA Contacts:

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

7) D_I Criteria: Groundwater Protection

Distance of Well from Source ¹	Score
≥ 500 feet	= 1
≥ 400 but < 500 feet	= 2
≥ 300 but < 400 feet	= 3
≥ 200 but < 300 feet	= 4
< 200 feet	= 5

¹Source = water retention facilities, confinement buildings, and application sites

References:

Dendy, D. and M. Ladd 1996. Comments on Draft Cumulative Risk Analysis, ACCORD Agriculture, Inc., Farnsworth, TX.

Goan, Charles. 1992. "Well Water Protection on Poultry Farms." University of Tennessee Agricultural Extension Service.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Well location is a potential factor contributing to possible ground water contamination.
- 2) Well and shaft (outside of well pipe) are potential conduits for ground water contamination.
- 3) Well head protection criteria does not consider construction and design parameters.

EPA Contacts:

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)

Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)

Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

8) D_I Criteria: Employment

Job Units ¹	Score
4	= 1
3	= 2
2	= 3
1	= 4
0	= 5

¹A job unit is equal to the state average income

References:

Canter, Larry W. 1977. Environmental Impact Assessment. McGraw-Hill Book Co. New York, NY.

Dendy, D. and M. Ladd 1996. Comments on Draft Cumulative Risk Analysis, ACCORD Agriculture, Inc., Farnsworth, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Job opportunities have both positive and negative economic effects on the local community.
- 2) Agricultural jobs lost may not equal the job (units) created.
- 3) Construction jobs, are not included since they are primarily short term, may include mostly migrant workers, and contribute little to the local economy.
- 4) Only a small percentage of construction materials (items that cannot be economically trucked in) and supplies are purchased locally and benefit the local economy.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

9) D_I Criteria: Odor

Total Number of Animals	Score
≤ 5 X threshold ¹	= 1
≤ 10 X threshold	= 2
≤ 15 X threshold	= 3
≤ 20 X threshold	= 4
> 20 X threshold	= 5

¹Threshold for swine = 750 animals

References:

Miner, J. Ronald and C.L. Barth. 1988. "Controlling Odors from Swine Buildings." Purdue University Cooperative Extension Service. West Lafayette, Indiana.

U.S. EPA, Region 6, 1996. Swine CAFO Odors: Guidance for Environmental Impact Assessment, Lee Wilson and Associates, Santa Fe, NM.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) An individual's perception of odor is primarily a subjective response based on attitudes and previous experience.
- 2) Odor may be associated with water pollution, flies, noise or other issues.
- 3) Odor is an indicator of ineffective air pollution control.
- 4) Residents may be reasonably close to CAFO facilities.
- 5) Animal units does not equal number of animals (e.g., 2500 swine over 55 lbs each equals 1000 animal units).
- 6) Swine odor is generally considered to be more offensive than cattle odor.
- 7) Odor includes not only "odor", but includes chemicals such as ammonia, methane gas, and hydrogen sulfide that may affect the health of nearby residents.

EPA contacts (name, mail-code, telephone numbers):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
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 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

10) D_I Criteria: Transportation

Number of Trucks/week	Score
≤ 7	= 1
7-14	= 2
15-21	= 3
22-28	= 4
≥ 28	= 5

References:

Carter, Larry W. 1977. Environmental Impact Assessment. McGraw-Hill Book Co. New York, NY.

Dendy, D. and M. Ladd 1996. Comments on Draft Cumulative Risk Analysis, ACCORD Agriculture, Inc., Farnsworth, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The less truck traffic in the area the lower the potential for negative impacts.
- 2) Trucks are defined as the vehicles used in feeding and transporting (live) animals.
- 3) Potential negative impacts include traffic accidents, dust, noise and odor.
- 4) Road surface conditions are considered to be unimproved, county roads.

EPA contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

11) D_I Criteria: Wildlife Habitat Effected

Acres Effected	Score
< 10%	= 1
≥ 10% and < 20%	= 2
≥ 20% and < 30%	= 3
≥ 30% and < 40%	= 4
≥ 40%	= 5

References:

Endangered Species Act of 1977, as amended.

U.S. EPA, 1996. Region 6 EPA Geographic Information System (GIS) Data Library. State Land Use Data Set, Office of Planning and Coordination, Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Net effects include both direct and indirect, or the total impacts of the facility (e.g. site and road construction and facility operation).
- 2) Wildlife habitats include floodplains, wetlands, bottomland hardwoods, rangelands, upland forests and grasslands.
- 3) "Acres effected" are compiled from State land use data sets.
- 4) The EPA will conduct a separate review with the U.S. Fish and Wildlife Service, and/or the National Marine Fisheries Service, as necessary, to document compliance with the Endangered Species Act (ESA).
- 5) The EPA will conduct a separate review with the U.S. Corps of Engineers and/or the U.S. Natural Resources Conservation Service, as necessary, to document compliance with Section 404 of the Clean Water Act.
- 6) There is no intended correlation between this impact score for wildlife habitats and the potential effect, if any, on listed Federal Endangered and Threatened Species, subject to the requirements of the ESA.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

12) D_I Criteria: Density of CAFOs¹

Number of CAFOs in 5 mi radius	Score
≤ 2	= 1
3	= 2
4	= 3
5	= 4
> 5	= 5

¹Includes EPA and state CAFO data

References:

U.S. EPA. 1996. CAFO Location Data Set. Region 6 GIS Data Library. Dallas, TX.

Oklahoma Department of Agriculture. 1996. CAFO Database. Oklahoma City, OK.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The more CAFOs in a watershed subunit, the greater the potential for negative impacts.
- 2) Five mile radius is used to be comparable with other Region 6 risk index analyses (e.g. Human Health Risk Index, Environmental Justice Index).
- 3) The majority of CAFOs are assumed to be in the same watershed, but there is the possibility that CAFOs can be in different HUCs.
- 4) The number of five CAFOs in a five mile radius was chosen by considering the size of the facilities (0.25-1 mi. sq.), desirable distance between the projects (2 miles), typical size of the 11 digit HUC, and the impacts of the CAFOs (runoff and odor) on the watershed.

EPA Contacts (name, mail-code, telephone number):

Gerald Carney, (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Tom Nelson (6WQ-O), EPA Region 6, Dallas, TX (X7128)
 Angel Kosfischer (6WQ-O), EPA Region 6, Dallas, TX (X2187)

13) D_v Criteria: Proximity of CAFOs¹

CAFOs Within 2 Mi of Each Other	Score
0	= 1
≥1	= 5

¹Includes Quadmapper and state data

References:

Oklahoma Department of Agriculture. 1996. CAFO Database. Oklahoma City, OK.

U.S. EPA, Region 6, 1996. Swine CAFO Odors: Guidance for Environmental Impact Assessment, Lee Wilson and Associates, Santa Fe, NM.

U.S. EPA, 1996. CAFO Location Data Set. Region 6 GIS Data Library. Dallas, TX.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) The closer the proximity of CAFOs, the greater the potential for negative environmental impact (e.g., odor, noise) to the watershed subunit.
- 2) The majority of CAFOs are assumed to be in the same watershed, but there is the possibility that CAFOs can be in different HUCs.

EPA Contacts (name, mail-code, telephone number):

Gerald Carney, (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Tom Nelson (6WQ-O), EPA Region 6, Dallas, TX (X7128)
 Angel Kosfischer (6WQ-O), EPA Region 6, Dallas, TX (X2187)

14) D_I Criteria: Phosphorus Budget

Crop Phosphorus Budget ¹	Score
≤ 100%	= 1
> 100% and ≤ 110%	= 2
> 110% and ≤ 120%	= 3
> 120% and ≤ 130%	= 4
> 130%	= 5

¹The Crop Phosphorus Budget percent is the ratio of the sum of the annual plant available phosphorus produced and the commercial phosphorus fertilizer to be used divided by the crop phosphorus that can be utilized each year times 100.

References:

U.S. EPA, 40 CFR 122, Wastewater Removal and Land Application, NPDES General Permit for Discharges from Concentrated Animal Feeding Operations.

U.S. Natural Resource Conservation Service (NRCS). Estimate of land Area Needed for Waste Application and Value of Nutrients Applied.

U.S. NRCS. Agricultural Waste Management Field Handbook, Part 651, Issued April 1992.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Annual plant available phosphorus is the amount of phosphorus available to the plant from the applied waste effluent.
- 2) Land application crops typically require commercial fertilizers in addition to nutrients from waste effluent.
- 3) Application rates of waste effluent might be limited by other parameters (e.g., salt loadings, nitrogen loadings, hydraulic loadings).
- 4) Buildup of phosphorus in the soil over time may have negative environmental impacts (e.g., runoff of accumulated phosphorus).

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)
 Gerald Carney (6EN-XP), EPA Region 6, Dallas, TX (X6523)
 Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

15) D_I Criteria: Endangered and Threatened Species

Section 7 Compliance ¹	Score
Yes	= 1
No	= 5

¹Section 7 of Endangered Species Act of 1977

References:

U.S. Department of Interior. 1977. Endangered Species Act. US Fish and Wildlife Service, Washington DC.

U. S. EPA. 1970. "Implementation Regulations for the National Environmental Policy Act", Washington, DC.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Federal non-compliance constitutes potential significant adverse impacts on listed endangered and threatened species.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)

Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)

16) D_I Criteria: Cultural Resources

Section 106 Compliance ¹	Score
Yes	= 1
No	= 5

¹Section 106 of National Historic Preservation Act

References:

National Historic Preservation Act of 1966, as amended, 16 U. S. C. Section 470-470w-6.

U. S. EPA. 1970. "Implementation Regulations for the National Environmental Policy Act", Washington, DC.

Definitions, Assumptions, Limitations, Uncertainties:

- 1) Federal non-compliance constitutes potential significant adverse impacts on cultural resources or historic properties.

EPA Contacts (name, mail-code, telephone number):

Joe Swick (6EN-XP), EPA Region 6, Dallas, TX (X7456)

Sharon Osowski (6EN-XP), EPA Region 6, Dallas, TX (X7506)